Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	CREDITS	TEACHING & EVALUATION SCHEME				
							THEORY			PRACTICAL	
							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTEE 601		POWER SYSTEM ANALYSIS AND CONTROL	3	1	2	5	60	20	20	30	20

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

The course will provide understanding of various control and tools of power system for analysis.

Course Outcomes:

After the successful completion of this course students will be able to

1. Understand concept of deregulation, distributed generation and other component of power system
2. Perform load flow studies, economic load dispatch and stability studies of power system
3. Analyze automatic generation and frequency control of power system

Syllabus:

UNIT I **6 Hrs**

Introduction

Concept of Deregulation, restructuring of power system, distributed generation, pricing of energy and transmission services, concept of smart grid and their key components

UNIT II **10 Hrs**

Load flow and load dispatch

Formulation of static power flow equations and solutions using GaussSeidel, Newton Raphson and FDLF methods, comparison of these methods, Economic operation of power system - Economic dispatch, Emission dispatch, line loss, ITL, economic dispatch using lagrangian multiplier method.

UNIT III **8 Hrs**

Stability studies

Steady state, dynamic and transients stability, Swing equation , equal area criterion, solution of swing equation using step by step method modified Eulers method and Ranga-Kutta method, methods of improving transient stability.

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Indore

Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

UNIT IV **8 Hrs**

Automatic Generation control

MVAR Voltage control Problem- Difference in control strategy over MW - f control, characteristics of an excitation system, DC AC and static excitation system, General block diagram representation of voltage regulators.

UNIT V **8 Hrs**

Frequency control- Coherency, control area, modeling of speed control mechanism, load damping, block diagrammatic representation of single and two area interconnected system, static and dynamic response, .optimum parameter adjustment.

Text Books:

1. D P Kothari and I J Nagrath , "Modern Power System Analysis" Tata Mc Graw Hill 4th Edition 2011.
2. C.L. Wadhwa , "Electrical Power Systems " New Age International (P) Limited Publishers, 7th Edition 2017.

Reference Books:

1. T.J.E. Miller, "Reactive power Control in Electric Systems" , Wiley India 2010.
2. Elgerd O.I., "Electric Energy Systems Theory", TMH, New Delhi, Second Edition 1983 27th Reprint 2007.
3. Prabha Kundur, Neal J Balu and Mark G Lauby, "Power system stability and control", Mc-Graw Hill Inc, New York, 7th Reprint 2009.

List of Practicals:

1. Analyze of power flow software's.
2. Determination of bus admittance and impedance matrix.
3. Perform power flow using gauss-seidel method.
4. Perform of power flow using Newton-Raphson load flow method
5. Perform of power flow using Newton-Raphson with rectangular coordinate system.
6. Perform of power flow using Fast decoupled load flow analysis.
7. Perform Economic dispatch in power systems.
8. Perform Load – frequency dynamics of single area power systems.
9. Perform Transient stability analysis of single area system
10. Analyze multi machine system stability analysis of power system

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Shri Vaishnav Vidyapeeth Vishwavidyalaya
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Indore

Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	CREDITS	TEACHING & EVALUATION SCHEME				
							THEORY			PRACTICAL	
							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTEE 602		RENEWABLE ENERGY	3	1	0	4	60	20	20	0	0

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

The course will provide understanding of various renewable energy sources, systems and applications in the present context and its need.

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Course Outcomes:

After the successful completion of this course students will be able to

1. Demonstrate the knowledge of solar energy and its applications
2. Demonstrate the knowledge of wind energy and its applications
3. Demonstrate the knowledge of bio energy and fuel cell.
4. Analyze economic aspect of renewable energy sources.

Syllabus:

UNIT I **8hrs**

Solar Energy: Energy available from the sun, spectral distribution, solar radiation outside the earth's atmosphere and at the earth's surface, solar radiation geometry, Instruments for solar radiation measurements, empirical equations for prediction of availability of solar radiation, radiation on tilted surface solar energy conversion into heat, types of solar collectors, evacuated and non-evacuated solar air heater, concentrated collectors, air heater and cylindrical parabolic collector

UNIT II **8 hrs**

Solar Energy Application: solar energy thermal storage, heating and cooling of buildings, solar pumping, solar cooker, solar still, solar drier, solar refrigeration and air conditioning, solar pond, heliostat, solar furnace photovoltaic system for power generation, solar cell modules and arrays, solar cell types, material, applications, advantages and disadvantages

UNIT III **8 hrs**

Wind Energy: Energy available from wind, basics of lift and drag, basics of wind energy conversion system, effect of density, angle of attack and wind speed, windmill rotors, horizontal and vertical axes rotors, drag, lift, torque and power coefficients, tip speed ratio, solidity of turbine, wind turbine performance curves, wind energy potential and site selection, basics of wind farm

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Indore

Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

UNIT IV **10 hrs**

Bio Energy : Types of biogas plants, biogas generation, factors affecting biogas generation, advantages and disadvantages, biomass energy, energy plantation, gasification, types and applications of gasifiers.

Hydrogen and Fuel Cell: hydrogen as a renewable energy source, source of hydrogen, fuel for vehicle

Hydrogen production: direct electrolysis, direct thermal decomposition of water, biological and biochemical methods of hydrogen production. Storage of hydrogen: gaseous, cryogenic and metal hydride, utilization of hydrogen fuel cell- principle of working, construction and applications

UNIT V **8 hrs**

Economic Analysis: Initial and annual cost, basic definitions, present worth calculations, repayment of loan in equal annual installments, annual savings, cumulative saving and life cycle cost, economic analysis of add on solar system, payback period, clean development mechanism

Text Books:

1. G.D. Rai , "Non-Conventional Energy Sources ", Khanna Publishers New Delhi, 5th edition 2013.
2. S. P. Sukhatme and J. K. Nayak "Solar Energy: Principles of Thermal Collection and Storage ", McGrawHill Education, 3rd edition 2015.

Reference Books:

1. G.N Tiwari and M .K Ghosal , "Renewable energy resources" Narosa Publication 2005.
2. Renewable Energy Resources – Twidell & Wier, CRC Press(Taylor & Francis)
3. John A. Duffie, William A. Beckman , "Solar Engineering of Thermal Processes", John Wiley, New York 4th Edition 2013
4. Shobh Nath Singh," Non-conventional energy resources" , Pearson Education India 2017

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Indore

Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	CREDITS	TEACHING & EVALUATION SCHEME				
							THEORY			PRACTICAL	
							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTEE 603		UTILIZATION OF ELECTRICAL ENERGY	3	1	2	5	60	20	20	30	20

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

The course will provide a comprehensive idea in utilization of electrical power such as drives, electric heating, electric welding and illumination, electric traction, electrolysis, refrigeration air-conditioning and automobile electric system.

Course Outcomes:

After the successful completion of this course students will be able to

1. Identify a heating/ welding scheme for a given application.
2. Explain various lamps and fittings in use.
3. Explain different schemes of traction schemes and its main components.
4. Identify the job/higher education / research opportunities in electric utilization industry.

Syllabus:

UNIT-I **9 hours**

Electrical heating- resistance heating, Induction heating, dielectric heating, arc furnaces, design of heating elements. Different methods of electrical welding, resistance welding, arc welding, control devices and welding equipment. Review of electrolytic principles, laws of electrolysis, electroplating, anodizing-electro-cleaning, power supply for electrolytic process, current and energy efficiency.

UNIT-II **9 hours**

Illumination Engineering, luminous efficiency, Incandescent lamps, arc lamps, gas discharge lamps- fluorescent lamp, effect of voltage variation on efficiency and life of lamps, Distribution and control of light, lighting calculations, solid angle, inverse square and cosine laws, methods of calculations, factory lighting, flood lighting and street lighting, Direct diffused and mixed reflection & transmission factor, refractors, light fittings.

UNIT-III **8 hours**

Special features of Traction motors, selection of Traction Motor, Different system of electric traction, Mechanics of train movement: simplified speed time curves for different services, average and schedule speed, tractive effort, specific energy consumption, factors affecting specific energy consumption, acceleration and braking retardation, adhesive weight and coefficient of adhesion.

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Indore

Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

UNIT-IV **8 hours**

Electric Drives Individual and collective drives- electrical braking, plugging, rheostat and regenerative braking load equalization use of fly wheel criteria for selection of motors for various industrial drives, calculation of electrical loads for refrigeration and air-conditioning, intermittent loading and temperature rise curve.

UNIT-V **8 hours**

Introduction to Electric and Hybrid Vehicles, Configuration and performance of electrical vehicles, Traction motor characteristics, tractive effort ,transmission requirement, vehicle performance and energy consumption.

Text Books:

1. Gupta, J.B., Utilization of Elect. Energy, S.K. Kataria & Sons; 2012 Edition (2012)
2. Rajput R.K., Utilisation of Electrical Power, Laxmi Publications, second Edition 2017

Reference Books:

1. H. Pratap, Art and Science of Utilization of Electrical Energy, Dhanpat Rai & co.,2014
2. Suryanarayan N.V., Utilization of Elect. Power: Electric Drives and Elect. Traction, New Age International, Second edition 2014.
3. Garg, G.C., Utilization of Elect. Power and Elect. Traction., Khanna publisher, New Delhi. 10th Edition. 2016
4. Open Shaw , Taylor, .Utilization of electrical energy., Orient Longmans, 1962.

List of Experiments:

1. Perform measurement of light intensity of Fluorescent lamp by Lux meter.
2. Perform measurement of light intensity of HP mercury vapour lamp by Lux meter.
3. Perform measurement of light intensity of HP sodium vapour lamp by Lux meter.
4. Perform measurement of light intensity of Compact Fluorescent lamp (CFL) by Lux meter.
5. Analyze welding equipment along with its accessories.
6. Analyze Electrical circuit of a refrigerator.
7. Explain Power factor improvement of a single-phase load using capacitor bank.
8. Selection of motors for different types of domestic load.
9. Analyze Electrical circuit of an air conditioner.
10. Compare different braking methods of a three phase induction motor.

List of Experiments beyond syllabus

1. Experiment with induction furnace by visiting a factory and to prepare a report
2. Discuss an electric locomotive by visiting any railway repair shop at a nearby station

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Shri Vaishnav Vidyapeeth Vishwavidyalaya
Indore

Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	CREDITS	TEACHING & EVALUATION SCHEME				
							THEORY			PRACTICAL	
							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTEE 604		ELECTRICAL SOFTWARE SIMULATION LAB	0	0	4	2	0	0	0	30	20

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

The course will provide knowledge of various softwares in field of Electrical Engineering.

Course Outcomes:

After the successful completion of this course students will be able to

1. Demonstrate the application of PSCAD in Electrical Engineering
2. Demonstrate the application of PowerWorld in Electrical Engineering
3. Demonstrate the application of Matlab and simulink in Electrical Engineering

List of Practicals:

1. Analyze reactive power and power factor in single-phase and three-phase circuits in PSCAD
2. Obtain the parameters of a 345 kV transmission line and modeling it in PSCAD.
3. Perform power flow calculations using MATLAB
4. Perform out power flow calculations using PowerWorld.
5. Obtain the current harmonics drawn by power electronics interface using Power World
6. Obtain the effect of sudden short-circuit on a synchronous generator output.
7. Analyze the effect of real and reactive powers on bus voltages.
8. Simulate various faults using MATLAB
9. Simulate transient stability in a 3-bus example power system using MATLAB.
10. Analyze the dynamic interaction between two control areas using Simulink modeling and economic dispatch using PowerWorld.

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Board of Studies
Shri Vaishnav Vidyapeeth Vishwavidyalaya
Indore

Registrar
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Indore

Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	CREDITS	TEACHING & EVALUATION SCHEME				
							THEORY			PRACTICAL	
							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTEI 401		MICROPROCESSOR AND MICROCONTROLLER	2	1	2	4	60	20	20	30	20

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. To gain knowledge of basics of Microprocessor & microcontroller & learn development of assembly language programs.
2. To learn the programming skills of 8086 microprocessor & 8051 microcontroller.
3. To learn the interfacing of external devices (LED, LCD, ADC, DAC) with the microcontroller 8051.

Course Outcomes:

The students will be able to

1. Apply the concept of buses, microprocessor & microcontroller architecture and interrupts.
2. Interface memory and I/O devices with 8051 microcontroller
3. Program assembly language / C programming of 8051 & 8086.
4. Design microcontroller based small system
5. Interface 8051 with LED, LCD, ADC, DAC etc.

Syllabus:

UNIT I **[08 Hrs]**

Introduction to 8086 Microprocessor

Overview of 8086 microprocessor. Architecture of 8086, Signals and pins of 8086 microprocessor, Concept of Memory Segmentation in 8086. Maximum Mode , Minimum Mode, Timing diagram, Comparative study of Salient features of 8086, 80286 & 80386.

UNIT II **[10 Hrs]**

Microprocessor 8086 programming

8086 Instructions set . Addressing mode of 8086, Assembly directives. Stack , Interupts of 8086, Assembly language programs of 8086.

Input-Output interfacing: Peripherals I/O. PPI 8255 Architecture and modes of operation, Interfacing to 16-bit microprocessor and programming, DMA controller (8257) Architecture, Programmable interval timer 8254, USART 8251.

UNIT III **[08 Hrs]**

Introduction to 8051 Microcontroller

Introduction, Difference between Microprocessors and Microcontrollers. Overview of 8051

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Board of Studies
Shri Vaishnav Vidyapeeth Vishwavidyalaya
Indore

Registrar
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Indore

Microcontroller family, Architecture of 8051 Microcontroller, The program counter and ROM space in the 8051, registers, 8051 register banks

UNIT IV **[10 Hrs]**

8051 Assembly Language Programming

Introduction to 8051 assembly programming, Structure of Assembly language, Assembling and running an 8051 program, 8051 data types and directives, interrupts

8051 Addressing Modes & Instruction set

Addressing modes, Accessing memory using various Addressing modes, Bit addresses for I/O and RAM, Arithmetic instructions, Signed number concepts and arithmetic operations, Logic and compare instructions, Rotate instruction, Jump, Loop, And Call Instructions, Call instructions time delay for various 8051 chips.

UNIT V **[10 Hrs]**

8051 Programming in C

Data types and time delay in 8051 C, I/O programming in 8051 C, Logic operations in8051 C, Data conversion programs in 8051 C, Accessing code ROM space in 8051 C, Interfacing with LEDs, LCDs ADCs, DACs.

Text Books:

1. A.K. Ray & K.M.Bhurchandi, Advanced Microprocessors and peripheral-Architecture, Programmingand Interfacing, Tata McGraw –Hill, 2012(Third Edition)
2. The 8051 Microcontroller and Embedded Systems Using Assembly and C, 2/e by Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin McKinlay,2008 (SecondEdition,PearsonEducation)
3. The 8051 Microcontroller & Embedded Systems using Assembly and C By Kenneth J. Ayala, Dhananjay V. Gadre, 2008 (Cengage Learning , India Edition).

Reference Books:

1. Hall Douglas V.,Microprocessor and interfacing, Revised second edition 2006, Macmillan, McGraw Hill
2. Using the MCS-51 Microcontrollers By Han Way Huang Oxford Uni Press,2000
3. Programming and Customizing the 8051 Microcontroller by Myke Predko Tata McGraw Hill,1999
4. Microcontrollers Architecture, programming, interfacing and system design by Rajkamal Pearson education,2009

List of Practicals:

1. Introduction to 8086 & 8051 kit, hardware features & modes of operationand Technique of programming & basic commands of kit.
2. Design programs for Arithmetic Operations.
3. Develop a program to find 1's complement and then 2's complement of a 16-bit numbers.
4. Develop a program to find larger of two numbers.
5. Write a program to shift an 8-bit number left by 2-bits.
6. Write a program to generate a square wave of 2 KHz Frequency on input pin.
7. Introduction to IDE and Assembler directives.

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Indore

8. Develop 8051 Assembly language programs using Arithmetic/ Logical instructions.
9. 8051 Assembly language programming for block data transfer between internal and external memory including overlapping blocks.
10. 8051 Assembly language programming for
    a. code conversions
    b. Timers in different modes.
    c. I/O port programming in embedded C.
    d. Programming of LCD in embedded C.

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Indore

Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	CREDITS	TEACHING & EVALUATION SCHEME				
							THEORY			PRACTICAL	
							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTEE 611		FLEXIBLE ALTERNATING CURRENT TRANSMISSION SYSTEMS	3	0	0	3	60	20	20	0	0

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

To familiarize the students with the basic concepts, different types, scope and applications of FACTS controllers in power transmission.

Course Outcomes:

Upon completion of the course, the students shall be able to demonstrate following knowledge, skills and attitudes

1. Understand various Power flow control issues in transmission lines for the purpose of identifying the scope and for selection of specific FACTS controllers.
2. Apply the concepts in solving problems of simple power systems with FACTS Controllers.
3. Design simple FACTS controllers.

Syllabus:

UNIT-I **[8 Hrs]**

Power Transmission control: Fundamental of alternating current (AC) power transmission, transmission problems and needs, the emergence of Flexible Alternating Current Transmission Systems (FACTS), FACTS controller and consideration. Uncompensated transmission lines and compensated transmission lines.

UNIT –II **[7 Hrs]**

Shunt Compensation: Principle, configuration, control and applications of Shunt Static Var Compensator (SVC) and Static Synchronous compensator (STATCOM).Comparison Between STATCOM & SVC.

UNIT –III **[7 Hrs]**

Series Compensation: Fundamental of series compensation, principle of operation, Application of Thyristor Controlled Series Capacitor (TCSC) for different problems of power system, TCSC layout, Static Synchronous Series Compensator (SSSC): principle of operation.

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Indore

Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

UNIT –IV **[9 Hrs]**

Phase Shifter: Principle of operation, steady state model of static phase shifter (SPS), power current configuration of SPS application.

Unified Power Flow Controllers (UPFC): Basic operating principles and characteristics, control UPFC installation applications, UPFC model for power flow studies.

UNIT –V **[7 Hrs]**

Transmission line steady State Operation: Lossless Transmission lines, Maximum Power Flow, Line loadability, reactive compensation techniques. Congestion management on transmission lines using FACT devices.

Text Books:

1. Hingorani, L. Gyugyi, 'Concepts and Technology of Flexible AC Transmission System', Standar Publishers Distributors, 1st Edition, 2011.
2. R.M. Mathur and R.K. Varma, 'Thyristor-Based FACTS Controllers for Electrical Transmission Systems', Wiley India Pvt. Limited Publications, 1st Edition, 2011.

Reference Books:

1. K. R. Padiyar, 'FACTS Controllers in Power Transmission and Distribution', New Age International Publications, 1st Edition, 2009.
2. Sang, Y.H. and John, A.T., Flexible AC Transmission Systems, IEEE Press (2006).
3. Ghosh,A. and Ledwich,G., Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers (2005).
4. T.J.E.Miller, 'Reactive Power Control in Electric Systems', Wiley Publications, 1982.

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Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	CREDITS	TEACHING & EVALUATION SCHEME				
							THEORY			PRACTICAL	
							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTEE 612		POWER SYSTEM ECONOMICS	3	0	0	3	60	20	20	0	0

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

To familiarize the students with the basic concepts, different types & policies of electrical power market and to make them aware with deregulated and restructured market.

Course Outcomes:

Upon completion of the course, the students shall be able to:

1. Define and discuss the major problems in power system economics.
2. Formulate these problems as optimization problems.
3. Describe the various types of electricity markets and discuss their purpose.
4. Discuss bidding strategies in electricity markets with perfect and imperfect competition.

Syllabus:

UNIT-I

Power Market Fundamentals [08 hours]

Regulation, deregulation why deregulate, problems with regulation, ancillary services and the system operator ,condition for deregulation, risk management, congestion management, available transfer capacity (ATC) for congestion management, screening curve.

UNIT-II

Competitions in Power Market [08 hours]

What is competition, advantage of competition for consumer, efficiency of perfect competition, marginal cost in power market, marginal cost fallacies, role of marginal cost, working with marginal cost, and results of marginal cost.

UNIT -III

Power Market and Structure [08 hours]

Define: Market power, price quality outcomes, three stages of market power, using price quality Out comes to show power, monopoly in power auction, market power on demand side.

Chairperson
Board of Studies
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Registrar
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Indore

Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

UNIT- IV

Restructure [07 hours]

Fundamental restructure system, transmission pricing, restructure models, open access same time information system OASIS, structure of OASIS, transfer capability of OASIS.

UNIT -V

Designing and Testing Market Rules [07 hours]

Design for competitive prices, design to prevent gaming, auctions, testing of market design, designing to reduce market power.

Text Books:

1. Stoft, Steven. Power system economics-designing market for electricity, IEEE press & Wiley-Interscience , May 2010.
2. Khetrapal, Pavan. Power system economics, technical publication 2014

Reference Books:

1. Shahidehpour, Mohammad, et al. Market Operations in Electric Power Systems: Forecasting, Scheduling, and Risk Management, Wiley-IEEE Press, March 2002.
2. Kirschen, Daniel S. Strbac, Goran . Fundamentals of Power System Economics, Wiley, August 2004

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Indore

Shri Vaishnav Vidyapeeth Vishwavidyalaya

Bachelor of Technology (Electrical Engineering)

SEMESTER VI

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	CREDITS	TEACHING & EVALUATION SCHEME				
							THEORY			PRACTICAL	
							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTEE 613		ENERGY AUDITING	3	0	0	3	60	20	20	0	0

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

To prepare the students to have a basic and practical knowledge of Energy Audit. To prepare the students to have a basic knowledge of pre Audit and post Audit.

Course Outcomes:

Upon completion of this course students will be able to:

1. Demonstrate various types of energy audit.
2. Conduct Different Strategies of energy audit.
3. Understand and analyze Energy Audit Instruments Combustion Analysis.
4. Methodologies of Conducting Energy Audit Preliminary Questionnaire.

Syllabus:

UNIT I **[8 Hrs]**

Energy Audit

Definition, Need and Objectives.

Types of Energy Audit

Internal Audit, External Audit, Walk through Energy Audit, Preliminary Energy Audit, Detailed Energy Audit, Investment Grade Energy Audit, Industrial Energy Audit, Utility (Services) Energy Audit, Commercial Energy Audit, Residential Energy Audit.

UNIT II **[8 Hrs]**

Energy Audit Strategies Monitoring and Control, Questioning the Need, Minimizing the Need of End Use, Minimizing the Losses, Operating the Equipment at Optimum Efficiency, Operating the Most Efficient Equipments from Set of Equipments, Minimizing the Idle Redundant Running, Proper Maintenance of the Equipment, Substitution with Efficient Equipment, Substitution with more Efficient Equipment, Substitution with more Efficient Process, Energy Storage, Fuel Substitutions, Quality Control and Recycling. Basic Components of Energy Audit Preparing for Audit Visit, Instrumentation, Data Collection Techno-economic Analysis, Safety Considerations.

UNIT III **[7 Hrs]**

Energy Audit Instruments Combustion Analysis, Temperature Management, Pressure Measurement, Flow Measurement, Humidity Measurement, Energy and Power Measurement,

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Light Level Measurement, Infrared Equipment, Tachometer & Stroboscope, P.F. Meter, Ultrasonic flow meter, and Steam & Air Leak Detector.

UNIT IV **[8 Hrs]**

Important Survey Items Buildings, Lightings, HVAC, Furnaces & Ovens, Boilers and Steam Lines, Air Compressor and Compressed Air Distribution Lines, Chillers and Chilled Water Distribution Lines, Process Water Generation and Distribution Lines, Electrical Distributions Transformers and Lines, Pumps, Fans and Blowers, Cooling Towers, Electrical Motors, Waste Heat Sources, Material Transport, Peak Load Equipments.

UNIT V **[8 Hrs]**

Methodologies of Conducting Energy Audit Preliminary Questionnaire, Review of Previous Records, Introductory Meeting, Walk through Tour, Flow Chart Construction for Detail Energy Audit, Identification of Required Audit Instruments, Finalization of Audit Schedule with the Company, Getting Detailed Data.

Post Audit Analysis Process Flow Diagram, Material and Energy Balance. Audit Subsidy Scheme of PCRA, IDBI and IREDA.

Text Books:

1. Albert Thumann, P.E., C.E.M. , Plant engineers & Managers Guide To Energy Conservation 8 th edition-2002, Published By The Fairmont Press , Inc 700 Indian Trail Liburn, GA30047.
2. BEE Volume I –Second Edition 2005 5. G.G. Ranjan: Optimizing Energy Efficiencies in Industry ,Edition-2003 McGraw Hill

Reference Books:

1. Instructions to Energy Auditors, Vol. - I & Vol. - II – National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
2. Energy Auditing, The Fairmont Press Inc. Published by Atlanta, Georgia Commercial Energy Auditing Reference Handbook, Third Edition 2016, Steve Dorty.

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